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## INTEGRATED SERVICES DIGITAL NETWORK FINAL REPORT

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January 1992

ASQB-GC-92-010

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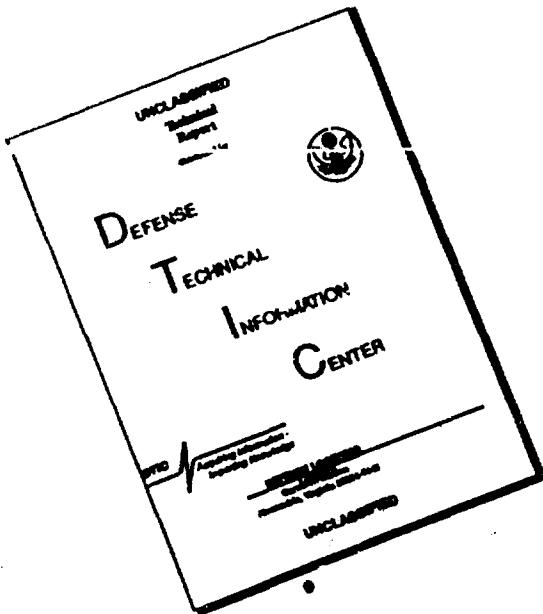


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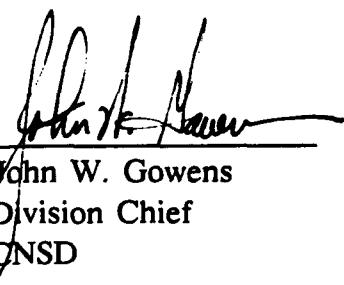
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**THIS REPORT HAS BEEN REVIEWED AND IS APPROVED**

s/



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Division Chief  
ONSD



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Director  
AIRMICS

# **INTEGRATED SERVICES DIGITAL NETWORK FINAL REPORT**

**January 1992**

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## INTRODUCTION

This report was prepared by the Martin Marietta Astronautics Group under contract to the U.S. Army Institute for Research in Management Information, Communications, and Computer Sciences (AIRMICS). The report discusses project efforts and products.

## PROJECT GOALS

The project had two primary goals:

1. Develop software to intercept an incoming calling line phone number (ICLID) and forward it to a data base application on another computer. An ICLID is an integral part of Redstone Arsenal's ISDN telephone system. The data base application is used in Redstone Arsenal's Customer Service Center to maintain records of help supplied to the general computer user population on the base.
2. Document ISDN implementation at Redstone Arsenal. The report produced from this effort would be designed to assist other Army sites who were considering a similar ISDN implementation. By documenting the "lessons learned", one might expect that the next ISDN implementation would proceed with fewer problems.

## SUMMARY OF PROJECT EFFORTS

The project developed a Microsoft Windows based application using Teleos Communications 'B-100' ISDN Terminal Adapter hardware for a PC compatible computer. The application supports two methods of accessing a remote data base developed for the Redstone Arsenal Customer Service Center: direct asynchronous access, as well as asynchronous access to an ISDN Terminal Adapter.

The application uses a R&D developed network kernel based upon AT&T's Streams architecture. The advantages of this architecture is that additional network interface or protocol stacks can be

easily inserted or removed without affecting the kernel. The advantage of a Microsoft Windows implementation is (cooperative) multitasking of applications as well as a refined graphical user interface.

The application is written in 'C' using a Borland compiler. There are approximately 10,000 lines of code (counted using a UNIX 'wc' utility).

An ISDN Implementation Guide was written to document "lessons learned" to date in the deployment of ISDN at Redstone Arsenal. The guide also serves others who may be considering deployment of ISDN. By allowing others to be aware of some of the more significant problems in bringing ISDN up to operational status, perhaps some "mistakes" will not be repeated. More significantly, perhaps others may arrive at improved solutions to some of the many problems involved with transitioning to a new communications system.

#### ENCLOSURES

This final report includes a copy of the ISDN Implementation Guide. Also included are the slides presented at the Initial Program Review in October 1991 and slides presented at the Proof-of-Concept Demonstration in January 1992.

**INTEGRATED SERVICES DIGITAL NETWORK**  
**MIGRATION GUIDE**

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## **CHAPTER 1.0**

### **1.1 INTRODUCTION**

This report was prepared by the Martin Marietta Astronautics Group under contract to the U.S. Army Institute for Research in Management Information, Communications, and Computer Sciences (AIRMICS). The report discusses a deployment of Integrated Services Digital Network (ISDN) at the U.S. Army's Redstone Arsenal in Alabama. In particular, the report discusses efforts behind the ISDN deployment.

### **1.2 PURPOSE**

The primary purpose of this report is to document "lessons learned" to date in the deployment of ISDN at Redstone Arsenal. A secondary purpose of the report is to serve as a guide for others who may be considering deployment of ISDN. By allowing others to be aware of some of the more significant problems in bringing ISDN up to operational status, perhaps some "mistakes" will not be repeated. More significantly, perhaps others may arrive at improved solutions to some of the many problems involved with transitioning to a new communications system.

This report is intended to be a "living document" in the sense that, across a planned three years of contract with the Army, the report would be annually revised and updated to reflect more detail and the latest in ISDN migration efforts at Redstone Arsenal. This particular report, dated January 1992, reflects the ISDN experience at Redstone at the end of the first year of contract.

## CHAPTER 2.0

### 2.1 REDSTONE ARSENAL CONFIGURATION BEFORE ISDN

A brief overview of the telephone service and system at Redstone Arsenal would be helpful in assessing the impact of an ISDN system.

Prior to ISDN Redstone Arsenal had approximately 21,000 subscriber lines on ESSX (Electronic Switching System) homed on a AT&T SESS central office switch. Before the change to digital service, the end user equipment (often referred to as Customer Premises Equipment or CPE) was largely Stromberg-Carlson "1A" phone sets (sometimes referred to as "six button" sets because of six translucent, lighted plastic buttons below the phone's rotary dial). These phone sets, still occasionally found on the base, are electromechanical and do not support digital service. Indeed the voltages in the system, combined with electromechanical switching, can introduce spurious emissions (sparks) that can be disruptive to data communications. A Stromberg-Carlson phone set was connected, via 25 pair cable, to key service units (KSUs) which were typically distributed one per floor of a building (depending, of course, upon the amount of users on a floor). The KSU was then connected to a distribution unit and then finally to a Stromberg-Carlson SC Stepper Switch.

Those familiar with this phone system will recall that it was a relatively simplistic system that tended to work quite well. Service was rarely disrupted: when the system worked, it worked well, and when it didn't work well, it didn't work at all. Such is the operation of an electromechanical system. There were few times when maintenance personnel could not correct a problem in the system. Card replacement solved the majority of problems.

Service changes in the Stromberg-Carlson system were labor intensive as hardware cards and wiring were physically manipulated to implement a change. From the point of view of training and skill levels required to effect a service change, an advantage to this system is that there is only a limited set of service options.

When ESSX came in, Redstone switched to single line digital service via an AT&T SESS switch. However, the signals in the system remained analog. Besides more features for the end user, digital service reduced the cost of implementing a change: software in the central office switch could accomplish what used to be done via hardware card replacement and wiring changes.

At divestiture, the end user was given the option of buying or leasing the CPE. The Army originally elected to lease its CPE. Later, as the advent of inexpensive, throw-away handsets made the purchase option attractive for many end users, the Army began to buy its own CPE.

As part of the Army's effort to migrate to ISDN, Redstone Arsenal was selected as a trial site for a large ISDN deployment. In fact, Redstone continues to be the site of the largest government trial of ISDN. The purpose of the trial was to evaluate new technology rather than to deploy better telecommunications service or to improve system maintenance costs. However, at the end of the trial period in January 1990, a study [1] did conclude that ISDN was cost justifiable.

## CHAPTER 3.0

### 3.1 REDSTONE ARSENAL CURRENT CONFIGURATION

In the late 1980's the U.S. Army at Redstone Arsenal began a trial of ISDN telephone service through the contracted services of South Central Bell (a subsidiary of the Bell South Company - one of the seven Regional Bell Operating Companies (RBOCs) created at divestiture). The trial was, and continues to be, the largest government trial of ISDN. A particularly unique aspect of the trial is the close cooperation with a service provider (South Central Bell).

An advantage of employing a service provider is the potential to rely on the corporate resources of the provider. One of the first steps in bringing up ISDN at Redstone was to host an evaluation team comprised of RBOC and AT&T personnel. This commitment by large corporations helps to ensure a successful deployment of ISDN. Indeed most of Redstone's users of ISDN have praise for the support effort by South Central Bell: same-day service and a competent technical team appear to be the factors behind the praise.

The level of service experienced at Redstone Arsenal may be invaluable in avoiding an avalanche of end user complaints. Experience shows that when faced with a problem in communications, for example between a user's PC and a remote computer where ISDN is a part of the path, users are often quick to blame the ISDN system rather than look for trouble in other links of the communication path. If it weren't for a high level of service, the ISDN system likely would not enjoy its current reputation and status.

The Army's Information Systems Command (ISC) provides the official interface between end users and South Central Bell. Requests for new or upgraded telephone service are reviewed by ISC to determine if ISDN might be a viable alternative. As an example, a user request for a dial up modem might be translated into a need for ISDN D channel service.

Typically the service to an end user is ISDN's "2B plus D" (2 bearer channels of service and a data channel). An ISDN B channel is a 64 Kbps physical circuit that can be used either for voice or data transmission. Each B channel is dynamically assignable to provide either voice or data service. Experience to date indicates that users use a circuit switched B channel to transmit data rather than X.25 packets across the B channel (if, for data transfer, they use the B channel at all). However, this experience must be tapered with the fact that software for packet switching across a B channel

has largely not been deployed.

An ISDN D channel has 16 Kbps of bandwidth and is primarily used for signalling between the end user's phone set and the central office switch. The D channel signalling does not require all 16 Kbps and a subset of the bandwidth can be used for data transfer. X.25 is the method used to pass information across an ISDN D channel. At Redstone, the D channel is often used at modem speeds (e.g., 2400 bps or 9600 bps) to transfer files to a printer or to access remote files.

An alternative to 2B+D service is multipoint service where several users are "multiplexed" onto 2B+D ISDN service. Users receiving multipoint service (sometimes called "passive bus") will share the 2 B channels - a first call is assigned to the one B channel and a second call is assigned to the next B channel. Multipoint service employs the second B channel more often, but there can be contention problems when both B channels are in use: no other calls can be placed or received.

To date, there are about 500 installed ISDN lines out of 21,000 telephone subscribers (or about 2 and 1/2 percent of the base's subscribers have ISDN service). As funding is approved, more users will be migrated to ISDN.

## CHAPTER 4.0

### 4.1 ISDN ADVANTAGES FOR REDSTONE ARSENAL

A number of applications were delivered with ISDN. Table One summarizes ten of the most popular applications. Most applications reside in the central office switch and are accessed via the user's phone set.

Table One - ISDN Applications

<u>APPLICATION</u>	<u>DESCRIPTION</u>
• Key System Replacement and Intercom	• Simulates multi-button phone set service provided to non-ISDN ESSX users.
• Electronic Directory	• Provides a centralized data base of user's names and phone numbers.
• Electronic Messaging	• Provides voice message transfer between end users.
• Pair Gain	• ISDN's capability to deliver multiple communications channels over a limited set of wires (as in 2B+D service or passive bus service).
• File Transfer	• Electronic transfer of computer data files between computers via <i>EasyStreet</i> software.
• ISDN Attendant Console	• Used by Redstone's Directory Assistance Operators.
• Modem, Printer, and Terminal Sharing	• Remote device access via <i>EasyStreet</i> software.
• SNA 3270 Access	• Access of IBM computers via 3270 terminal emulation over emulated SNA links
• ISDN Video Conferencing via Macintosh Executive Network	• Video conferencing between suitably equipped Macintosh IIc computers.
• Military Police Security	• Provides Calling Line ID, location, time to MPs.

Of all the applications listed in Table One, only *EasyStreet*, from Newbridge Networks Corporation, resides on a computer. A number of applications touting ISDN connectivity are available. *EasyStreet* was selected because it was the only application, at the time, offered in both Macintosh

and PC versions.

A Military Police security application was custom constructed by South Central Bell in their laboratory (Building 4506) to meet the specific needs of the military police. The system is akin to an enhanced 911 type system in that the caller's phone number and location is displayed on each call to the MPs.

Recently a new application has come on line for interactive training. The application includes a Graphical User Interface (GUI) and can be remotely accessed via terminal emulation software.

The ISDN D channel is used most often to transfer data via X.25. Access to the D channel may be either directly via an ISDN Terminal Adapter hardware card installed in a computer or via a serial line between the computer and a TA in most ISDN phones. The latter scenario is the norm at Redstone. A variety of software packages supporting asynchronous communications are in use: among them are SmartCom, ProComm, and NCSA Telnet. A typical computer communications path is depicted in Figure One.

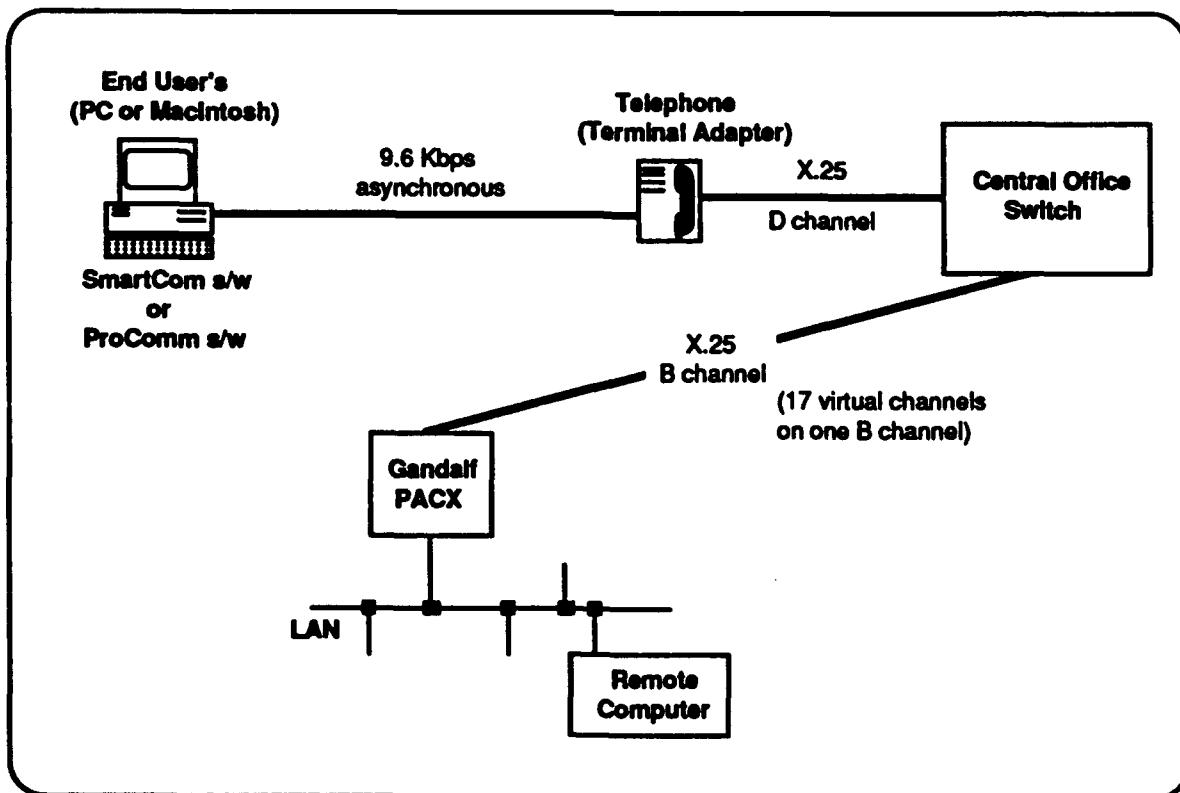


Figure One: MicroComputer Communications: Access to LANs via ISDN

Having up to 19200 baud between the computer and ISDN phone set is somewhat of an improvement (of course the high speed between the computer and phone set may be somewhat tapered by the available bandwidth for an X.25 connection since effective X.25 speed depends upon the quantity of simultaneous X.25 links in progress at a given moment). But most users are satisfied with the often-better-than modem service of X.25 over the D channel.

It might be noted in passing that ISDN provides a data connectivity path. Transparent connectivity, where the end user is alleviated from entering connection or configuration commands to devices encountered in a communications path, is not yet a reality at Redstone. But for that matter, transparent connectivity (across ISDN or most other networks) is not yet a reality elsewhere. The user wishing to use ProComm to establish a terminal session with a remote computer at Redstone will have to be somewhat familiar with the configuration commands for the computer's serial port, the phone's TA port, and the Gandalf PACX switch. These devices are depicted in Figure One.

ISDN can provide LAN like connectivity amongst those with ISDN service. Whether it is cost effective is beyond the scope of this paper. The tradeoff is between the cost of single line telephone service and LAN access software and hardware verses either B+D or 2B+D ISDN service. Then again there might be further cost reduction if a large volume of ISDN service were purchased. However, at Redstone, it was not intended that ISDN compete with LANs. Rather, ISDN can sometimes provide another alternative connectivity path. There has been a couple of instances where ISDN service to a group of users has avoided the need to separately install a LAN: these instances are more the exception rather than the rule.

## CHAPTER 5.0

### **5.1 ISDN TRANSITION METHODOLOGY AT REDSTONE**

The effort to transition to ISDN at Redstone has generally been smooth. If recommendations based on experience were to be offered, two points would be prominent.

### **5.2 SERVICE PROVIDER RECOMMENDATION**

Probably the most significant recommendation would be to involve a service provider from the beginning of the transition effort. While South Central Bell was indeed involved with ISC from the beginning of the Redstone transition effort, there is little doubt that the effort would have experienced many more problems without such expertise. Close cooperation with the service provider is essential. In fact, at Redstone an ISC representative worked in the same building as South Central Bell employees. Coordination was on a daily basis.

### **5.3 PLANNING AND TRAINING**

Planning for the transition was never formally documented. User's requesting new service, whether ISDN or a service that could be translated to ISDN service, have their request evaluated to be sure ISDN would be an effective option. For example, a user request for a modem and separate telephone line would likely be interpreted as a possible candidate for ISDN service.

South Central Bell provides training for end users which is usually in the form of instruction on how to use the features of a newly installed ISDN phone set. On occasion, a high level user will receive advance training prior to installation of ISDN to avoid service disruptions. Training is not so much technical in nature as it centers on what each button on an ISDN phone set accomplishes.

### **5.4 END USER NEEDS**

End users often assimilated the new technology faster than expected. For example, early on in the transition effort it was recognized that the system that could report location of an incoming call could be advantageous to the military police. Since a commercial application did not exist, development of a custom application was undertaken. While the final product was welcomed, the time to its deployment has drawn criticism.

As user's gain more technical savvy with ISDN, more requests for applications that use ISDN will find their way to the attention of developers. An application currently under development in South Central Bell's ISDN laboratory at Redstone, video teleconferencing via a user's MacIntosh, has generated a large amount of interest and user support.

## CHAPTER 6.0

### 6.1 ISDN APPLICATIONS AT REDSTONE

While this report has discussed many of the applications in use in the ISDN system at Redstone, some mention should be made regarding applications that are still needed.

As mentioned earlier in this report, video teleconferencing has received wide user support. South Central Bell is currently working this application in its laboratory.

A need for secure communications via the all digital ISDN system has also been identified. Currently users having a need for secure telecommunications employ "STU" telephone sets, which have an National Security Agency (NSA) approved encryption algorithm and a separate analog line. The digital nature of ISDN would appear to support data encryption more readily than an analog system.

The *EasyStreet* application discussed earlier in this report is widely used to access files on a remote computer. However it has a drawback in that file protection is either all or nothing. The owner of the remote computer can choose either to prevent access or allow access to all of his files. A need has been identified for more robust file protection where a subset of all files on a computer may be designated as accessible by outside users.

B channel packet software is another need. As mentioned earlier, increased use of software that transfers large amount of data, such as software with a GUI, will drive an increase in bandwidth requirements. The second ISDN B channel, with its 64 Kbps bandwidth, might be used to satisfy such requirements.

Finally, a need that is probably not quite at the top of the list (yet) is transparent connectivity. It is common to find user apprehension in manipulating devices in a communications path. If the network connectivity were transparent to an end user, an increase in network use could be expected. Network transparency is akin to "user friendly networks". When their use does not involve technical skills, more users can be expected to use the networks (sometimes whether they know it or not).

As user savvy increases with ISDN, other needs will be identified. The initial steps in fielding a trial ISDN system are completed at Redstone. End users will now gain experience. New applications

will be deployed. And users will adapt to the new technology and come up with new ways to use it. The next few years at Redstone will be a most interesting time as the system and users "mature".

A National ISDN User Forum (NIUF), sponsored by the U.S. Department of Commerce's National Institute of Standards and Technology, has been chartered to create a strong user voice in the implementation of ISDN applications. Additionally the NIUF's objective is to identify ISDN applications, development implementation requirements, and facilitate their introduction. Currently the NIUF has a repository of more than 100 requests for ISDN applications. The NIUF's efforts may well have an impact on users at Redstone in the years to come.

## **APPENDIX A**

### **REFERENCES**

1. **Analysis & Assessment of Redstone Arsenal's Pilot ISDN Project**, JRH Associates, November, 1990.
2. Personal interviews with Timothy Bell, Communications Officer, USAISC-MICOM, November 1991, January 1992.
3. Personal interview with Martha Dodson, USAISC-MICOM, November 1991.
4. Personal interview with Matt Petty, World Computer Sys., November 1991.
5. The following individuals at South Central Bell are recognized for their time in clarifying and contributing to a more in-depth understanding of ISDN: Dave DeLoach, Wayne Fleming, and Charlotte Webb.

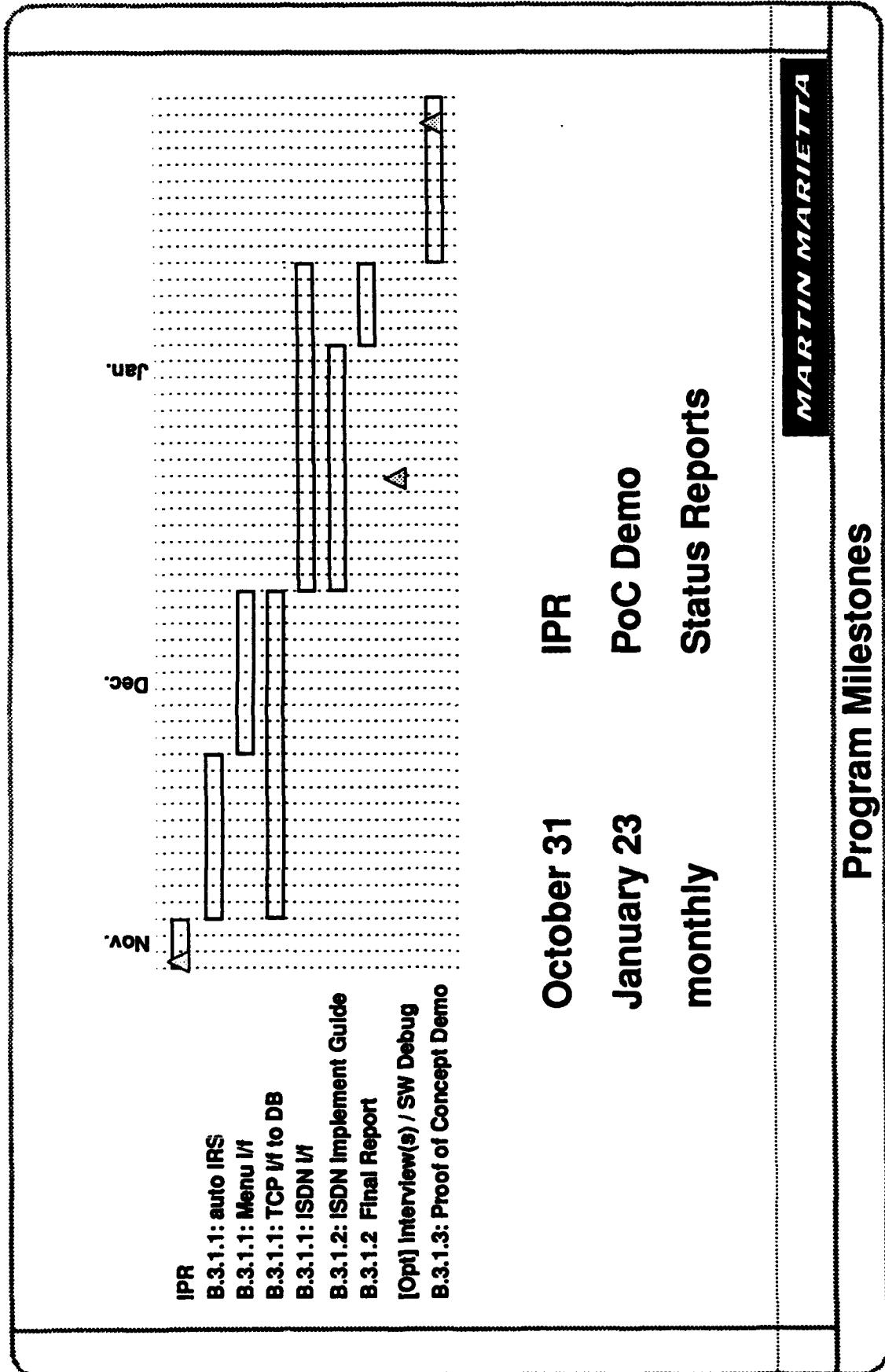
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**Redstone Arsenal's  
ISDN Migration & Customer Service Center Upgrade**

**31 October 1991**

**T.N. Washburn**

**MARTIN MARIETTA**



## Tasks

B.3.1.1: auto IRS

B.3.1.1: Menu i/f

B.3.1.1: TCP i/f to DB

B.3.1.1: ISDN i/f

B.3.1.2: ISDN Implementation Guide

B.3.1.2 Final Report

B.3.1.3: Proof of Concept Demo

## Deliverables

ISDN Implementation Guide

Final Report

PoC Demo

Status Reports

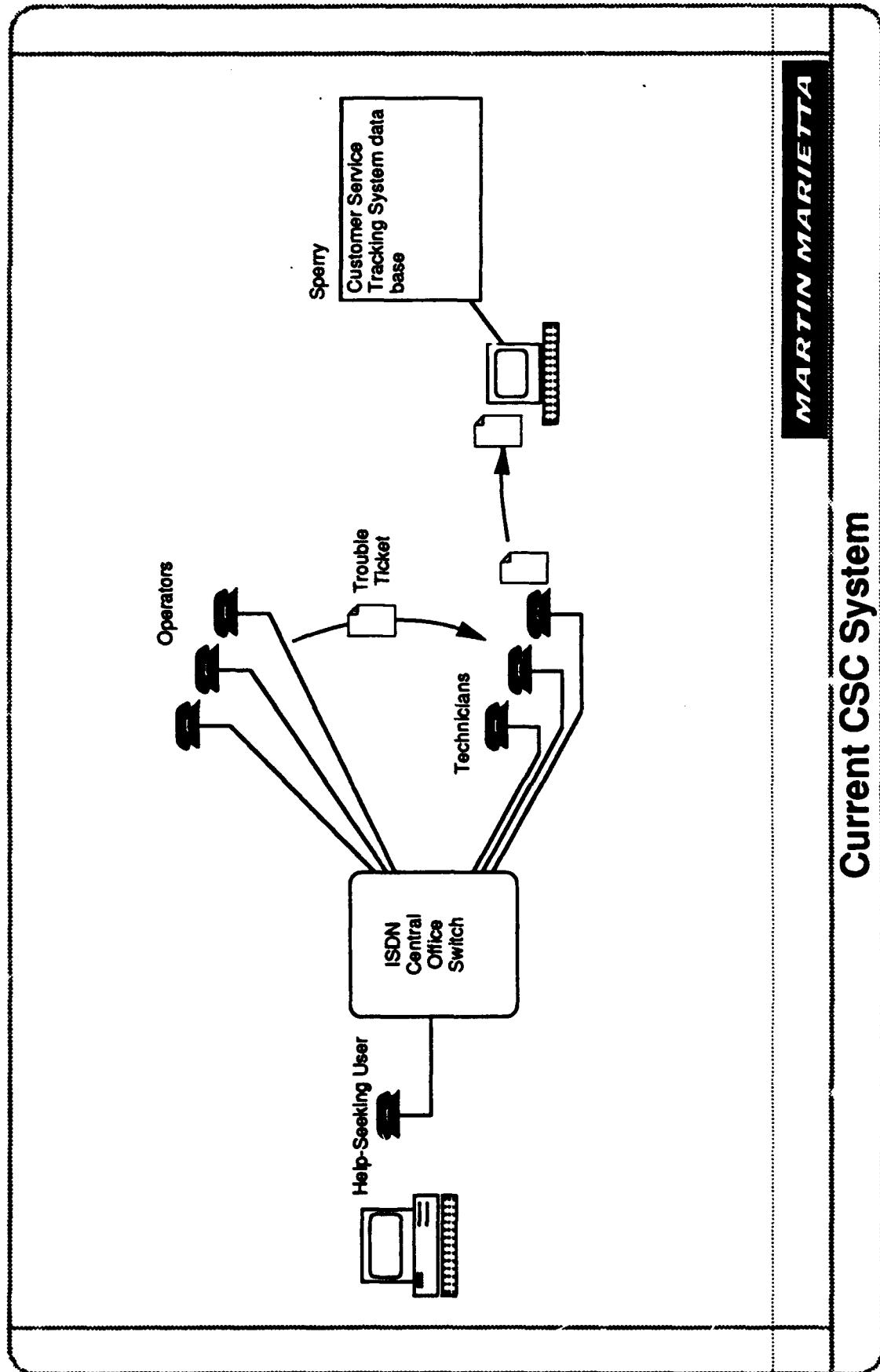
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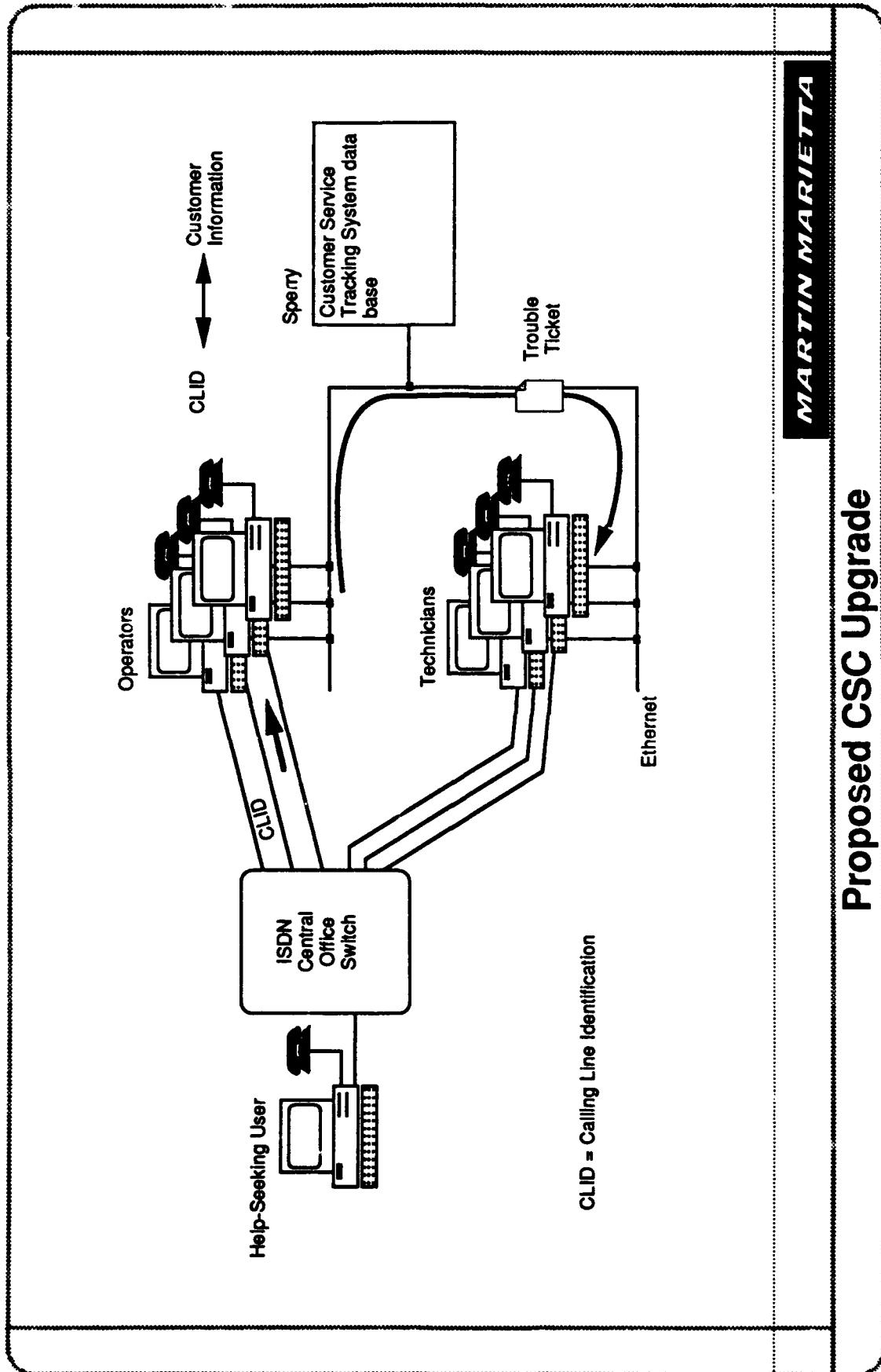
**First Year Program Tasks / Deliverables**

<u>Year</u>	<u>Deliverable</u>
1st Year	<ul style="list-style-type: none"> <li>• ISDN Implementation Guide</li> <li>• Proof-of-Concept Demonstration of ISDN Based CSC System at Redstone</li> </ul>
2nd Year	<ul style="list-style-type: none"> <li>• User Manual and Software Guide for ISDN Based CSC System</li> <li>• Installation of Prototype ISDN Based CSC System</li> <li>• Upgraded ISDN Implementation Guide</li> </ul>
3rd Year	<ul style="list-style-type: none"> <li>• User Manual and Software Guide Supporting LAN Access to CSC System</li> <li>• Installation of Prototype LAN Access System for CSC System</li> <li>• Improving LAN Access to CSC System</li> <li>• Upgrade ISDN Implementation Guide</li> <li>• ISDN Automation of Redstone Physical Security System</li> <li>• CSC Extension to Support New Technical Support Groups</li> <li>• User Manual and Software Guide Supporting CSC Enhancements</li> <li>• Installation of Enhanced CSC System</li> <li>• Enhanced ISDN Implementation Guide</li> </ul>

*MARTIN MARIETTA*

**Three Year Program Tasks / Deliverables**





# ISDN Implementation Guide Outline

- Transition Methodology
- User Training
- Cutover Schedule
- Technical Problems / Issues Encountered
- Administrative Problems / Issues Encountered

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**ISDN Implementation Guide**

**Redstone Arsenal**

**Timothy Bell, Communications Officer**

**Randall Knight, Redstone**

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**Jay Gowens, Chief CNSD**

**Lt. Col. Joseph Hanratty, CE Officer**

**Fred Fong**

**Martin Marietta**

**Reid Clausen, Research & Technology Director**

**Tom Washburn, Project Lead**

**Dick Liu, Project Technical Lead**

**Jason Preese, Business Development**

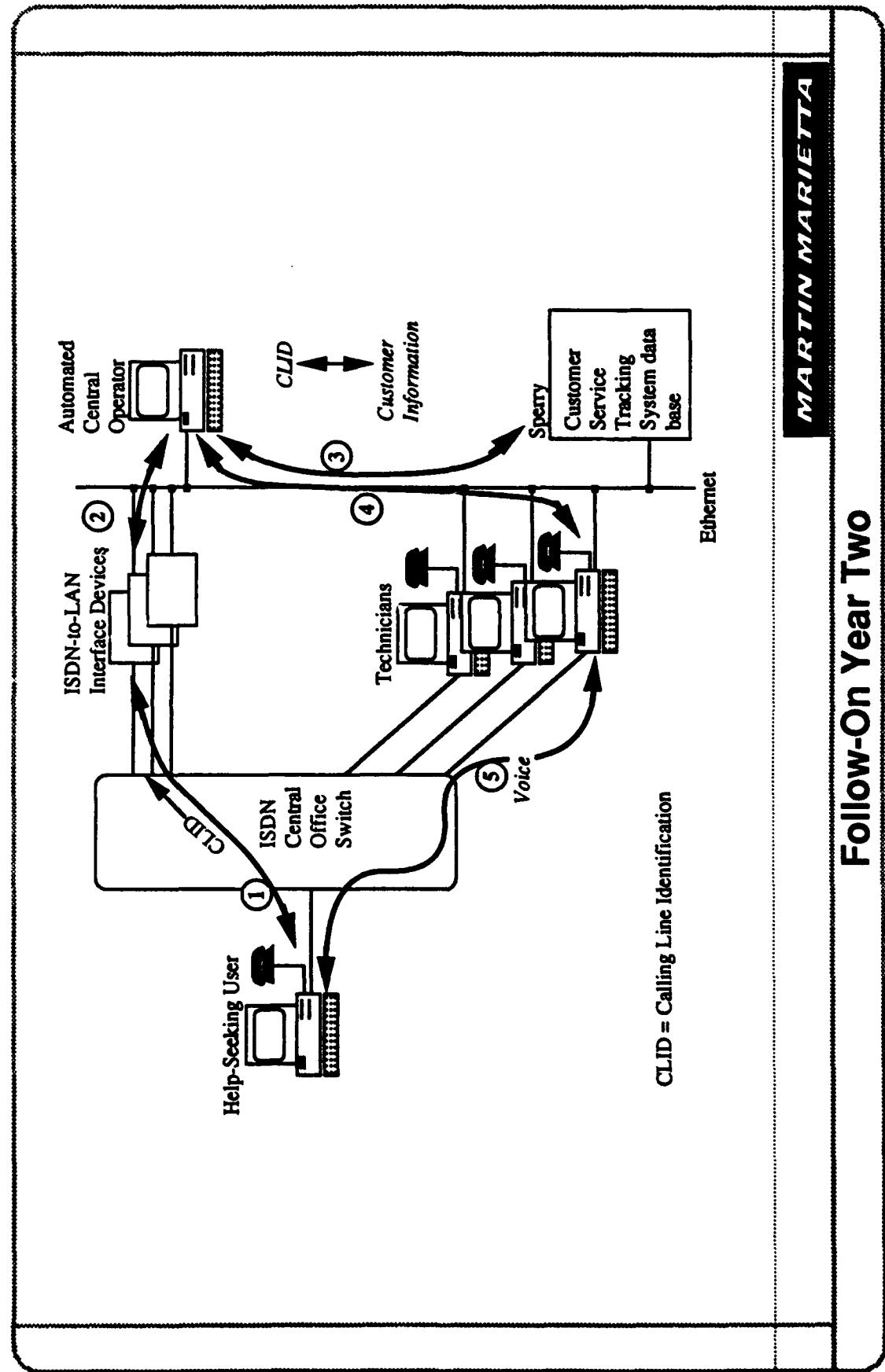
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**Key Personnel**

<u>Qty</u>	<u>Description</u>
<b>For each Operator and Technician position:</b>	
1	IBM PC/AT type computer based on an 80286 CPU running MS-DOS 3.3 (minimum)
	20 MB hard disk space (minimum)
	serial communications port (and related cable & hardware to connect (if necessary) to the Sperry's serial port)
	MicroSoft Windows runtime environment
1	Teleos B-100 PC/TA (ISDN Terminal Adapter Board for the computer) and software
1	analog telephone (to be plugged into the Teleos B-100)
1	Western Digital "FastCard" WD-8003 Ethernet Board and software
<b>For each User position:</b>	
	same suite of equipment as per the Operator position, sans the Ethernet board and software (i.e., the User position does not require the Ethernet equipment).
<b>Additionally:</b>	
1	operational TCP/IP based LAN connecting Operator's computer with the Sperry computer and with the Technician's computer.
1	ISDN Central Office Switch (e.g., an AT&T 5ESS) with one of the following options to support call distribution: Automatic Call Distribution (ACD), Hunt Groups, or Rotaries.

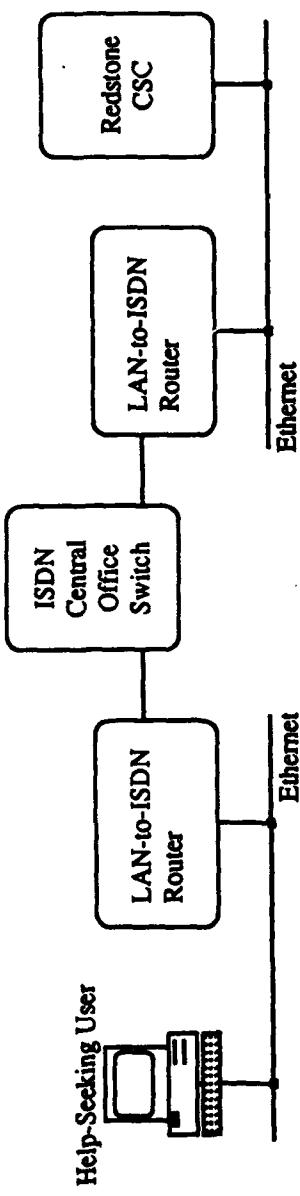
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## Technical Needs



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**Follow-On Year Two**



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**Follow-On Year Two**

- Dynamic Bandwidth Allocation in Router
- CCTV Security System
- CSC Extension to Support New Technical Support Groups
- Upgrade ISDN Implementation Guide
- User Manual & Software Guide

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**Follow-On Year Three**

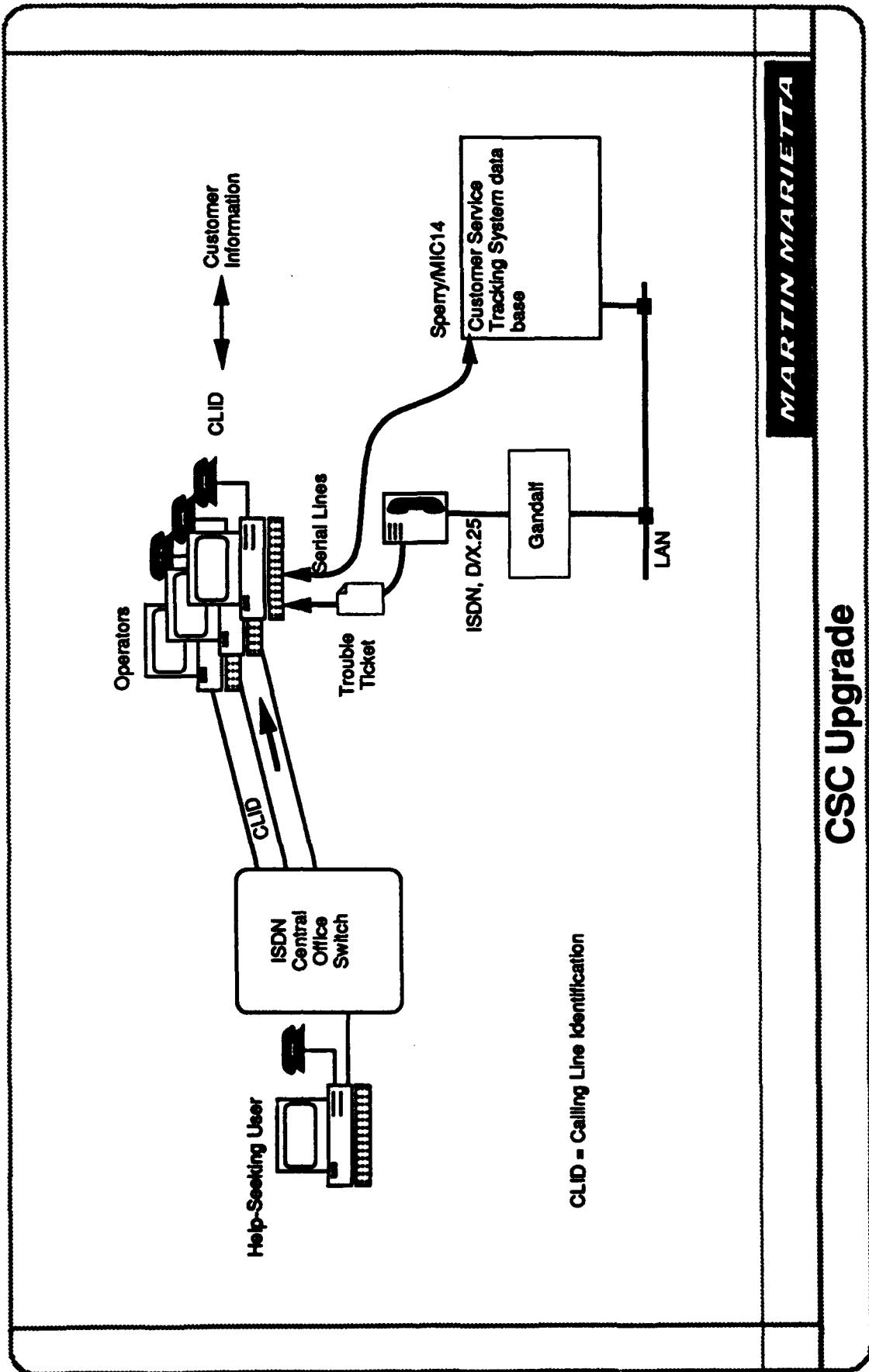
**AIRMICS**

**Redstone Arsenal's  
ISDN Migration & Customer Service Center Upgrade**

**January 23, 1992**

**T.N. Washburn**

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**CSC Upgrade**

## ISDN Implementation Guide Outline

- Transition Methodology
- User Training
- Cutover Schedule
- Technical Problems / Issues Encountered
- Administrative Problems / Issues Encountered

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**ISDN Implementation Guide**

"Requirement"

- Intercept and Forward ICLID to Customer Service Tracking System
- Access via ProComm at 19.2 Kbaud

or

Access via Telnet on LAN (Ethernet)

Access via PC or Macintosh

Slow Response of Current CSTS

Telephone Number Display: Prefer Seven Digits w Dash

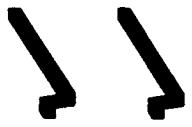
Store Phone Number in Environment Variable

Capability to Handle 3 Simultaneous Incoming Calls

Use HotKey to Initiate a Trouble Ticket

System Admin's would like Electronic Access to CSC

Status at PoC Demo



Phase II

(Macintosh: Phase II)



Phase II

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**Project Requirements**

- Capability for Direct Asynch Access & ISDN TA Access to CSTS

- Previous Session State Detection

- Automatic Telephone Keypad Popup upon Incoming Call

- Includes Capabilities:

- Outward Dial

- Hold

- Transfer

- Conference

- Customizable to Separate User's

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**Software Enhancements**

- MS Windows Based (Coop Multitasking)
- Employs ProComm, Teleos ASK-100 Dev Sys
- Constructed with Borland C 3.0, Windows SDK, Window MakerPro
- B-100 uses a "2500" type Phone Set
- Password Storage is Encrypted

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**Software Details**